AN ORPHAN COLONY OF *POLISTES PALLIPES* LEPEL.

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It was the seventh of August, 1912. Beneath the eaves of a small, well painted railroad shed in the suburbs of St. Louis, a small nest of *Polistes pallipes* Lepel. was hanging. There were nine capped cells containing pupæ and fifteen open cells containing larvæ in all stages of development, from recently laid eggs to forms almost ready to enter the pupal stage; but the only adult inhabitant was the female wasp (the "widow-mother" or "queen") that founded the colony. This paper nest was transported several miles to my in-door insectary and suspended from a shelf. The "widow-mother" was left behind.

On the morning of the fifteenth of August four wasps were resting on the nest; evidently they had emerged over night. As I approached, they elevated the front portions of their bodies and waved their antennæ. I offered them some honey on the end of a short glass rod. They ate it immediately, even reaching out to secure it. I then offered them some honey on a steel spatula and they ate that. Placing some honey on the tip of my index finger, I presented it to them. After a moment's hesitation they cautiously sipped the honey. Normally the "widow-mother" of the colony would have fed these newly emerged wasps with food held between her jaws. Apparently these wasps possess an instinctive tendency to sip food from any small object that happens to be near.

The next morning, August sixteenth, when I approached the nest with a spatula of honey, the wasps hung down by their hind legs to sip it. One, in her eagerness, stretched so far out that she lost her balance and fell to the shelf below. Most of these wasps seemed to be eating for the gratification of self; one, however, acted differently. After sipping the honey she walked about the nest, entering cell after cell. She was feeding the larvæ on honey. The heads of the larger larvæ reached so near to the rims of the cells that I could see the nurse as she placed the drop of liquid to their mouths.

All of the four wasps that were on the nest emerged after I had left the insectary in the afternoons. On the morning of the sixteenth I arrived at the insectary at a quarter past seven. One immature wasp had partly emerged from its cell and seemed to be resting. Its head, its first pair of legs and its prothorax were protruding from the cell. After I had fed the wasps in the manner mentioned in the above paragraph, the remainder of the time was devoted to watching the emerging wasp. By slowly wriggling, it succeeded in freeing the second pair of legs, the mesothorax, the wing pads, and a portion of the metathorax. These wing pads were slender and sub-conical and did not reach quite to the beginning of the abdomen. By the time this much had been accomplished it was twenty-seven minutes after seven. From this time on, the behavior of the emerging insect consisted of various combinations of the following movements: squirming from side to side through angles varying from forty-five to ninety degrees, flexing the body forward and straightening it upwards, and bending the body to the right or to the left. Usually the antennæ were waving. Most of the time the forelegs were folded across the prosternum, occasionally they were flexed or straightened; but they took no part in either shoving or pulling. The second pair of legs were frequently pulling or pushing in an effort to help free the body. From twenty-five minutes after seven in the morning to half past three in the afternoon—nine tedious hours —this emerging wasp was watched continuously. At the last mentioned hour fatigue and other duties made it necessary for me to leave for the day. At seven o'clock the next morning this wasp was dead; but another wasp had emerged from a neighboring cell. While the wasp that died in an effort to emerge was making strenuous efforts to escape from its cell, the wasps of the nest frequently approached it; but none attempted to assist it.

On the eighteenth it was one o'clock in the afternoon when I visited the insectary. In the meanwhile two more wasps had emerged from their cells and two of the largest larvæ had woven their cocoons, thus capping their cells. These larvæ fasted from the seventh of August to the fifteenth, and from that time to the eighteenth the only food they received was honey; yet the caps they wove for their cells were as perfect as those on the other cells. Being acquainted with Margaret Morley's experience with orphan

wasp larvæ I was entirely unprepared for this outcome. Miss Morley [1] fed her larvæ on maple syrup and raw egg. The larval period was prolonged for at least two weeks and the caps spun by the larvæ were thin and transparent. The caps spun by the larvæ observed by me were as opaque as the ordinary caps.

At five minutes to two, on that same afternoon, a wasp was detected sipping honey from a Minot watch-glass. After making a flight of orientation she flew towards the nest, which was only ten feet away. Bethe believes that bees are led home by an unknown force which acts reflexly. Had he been present that afternoon he would have obtained material for much thought. That nest was on the under side of the uppermost shelf of a bank of five. The space between each shelf and the next was one foot. For descriptive purposes let us call the spaces above the shelves A, B, C, D, and E respectively. The nest was in space D. The wasp flew into space B; then, after searching around, flew out and entered space C, where it searched about for a minute or two. From there it went to space D. Although the nest was in that space the wasp failed to find it and left it and flew into space E. After searching there a short time it returned to D and succeeded in finding the nest. After feeding the young and making a flight of orientation the wasp revisited the bottle of honey. From the honey it flew, in practically a straight line, to the nest. Although this behaviour does not harmonize with Bethe's hypothesis, yet it is in perfect accord with the theory that memory of the environment assists hymenopterous insects to find the way home.

Up to the nineteenth of August not one of the wasps had been outside of the insectary. At all times they were well supplied with honey; but no substitute was made for the usual insect diet. At half past two on that day I noticed a wasp biting at the cap of one of the pupal cells. Soon a second and then a third wasp began to bite at the cap. Bit by bit the cap was picked away. As the hole became larger and larger all of the wasps on the nest began to move about in an excited manner. In an hour the hole was about as large as the cross section of the cell. The activity of the wasps was now increased. They seemed to vie with each other for a chance to bite at the neck of the partly exposed pupa.

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[1] Morley, Margaret. Wasps and Their Ways. 1900, pp. 177–180.

Soon they had severed its head from the body and had begun to feed upon the contents of its thorax. They had become cannibals! Apparently the lack of food rich in protein was the cause.[1]

Fearing that all of the pupæ might share the fate of this one, I decided to supply food containing proteids in greater abundance. In my garden I captured some small caterpillars of the cabbage butterfly (*Pieris rapæ*). I picked up one that was about one inch long and offered it to the wasps. One of the wasps seized it with her first pair of legs. Without stinging or making any attempt to do so, she proceeded at once to chew the posterior end of the larva. According to Margaret Morley,[2] Belt remarks: "A specimen of *Polistes carnifex* was hunting for caterpillars in my garden. I found one about an inch long and held it out towards it on the point of a stick. It seized it immediately, and commenced biting it from head to tail, soon reducing the soft body to a mass of pulp. It rolled up about half of it into a ball and prepared to carry it off." The behavior of *Polistes pallipses* Lepel. was unlike this. The wasp did not bite the larvæ from tail to head; but, holding the caterpillar with her fore feet, she rotated it on its longitudinal axis and gradually elevated it while she malaxated the posterior end of the squirming insect until her jaws contained a large ball of pulpy matter. She then dropped the rest of the caterpillar and flew to her nest where she fed the larvæ in the uncapped cells. She would place the juicy mass aganst the mouth of a larva and then remove it, always leaving a portion of it clinging to the mouth of the young wasp. Although several of the wasps accepted the caterpillars offered, only one seemed to take any part in feeding the young. A few of the wasps refused to accept the caterpillars that I presented to them; but they accepted such food from the jaws of other wasps. One even stole food out of the mouth of one of the larvæ. From now on these wasps were daily supplied with insect food, and they always treated the caterpillars in the manner described above. An

[1] Margaret Morley, in her book on "Wasps and Their Ways," describes a case of cannibalism. Speaking of a nest of wasps that she had captured she says: "It was necessary to keep the nest shut up in a box for several days, and in that time the confined wasps, perhaps becoming crazed with adversity, so far forgot themselves as to pull the larvæ out of the cells and suck their juices." There were numerous larvæ in the nest I studied; but the wasps passed them by and laboriously uncapped a cell and fed upon a pupa.

[2] *Op. cit.*, pp. 184, 185.

opening was left above the door, with the hope that the wasps would learn to go afield and capture their own prey.

At half past five in the afternoon, when I left the insectary for the day, all of the wasps were resting quietly or else cleaning their antennæ. At a quarter to six next morning, when I returned to the insectary, I discovered that the wasps had eaten out all of the contents of the thorax of the pupa and had thrown the body to the shelf below. The contents of the abdomen had not been touched.

From this date to the twenty-eighth of August the wasps were daily fed on caterpillars of the cabbage butterfly or on other lepidopterous larvæ. Certain wasps would accept the larvæ and, after malaxating them in the manner described above, feed the wasp larvæ and even the adults. Other wasps would not take the caterpillars. It may be that these latter wasps acted as guardians of the nest. If so they were not very efficient. The rearing on the hind legs, the darting forward and backward, the waving of the antennæ and the moving of the wings, although they may be defensive movements, certainly are not formidable. I placed some caterpillar larvæ on the top of the nest. The wasp that had been functioning as nurse captured one of them; but the other wasps on the nest made no attempt to either bite or sting them. Indeed, the only stinging done during the time these wasps were under observation was when I was attempting to induce them to feed upon the larvæ of the squash bug (*Anasa tristis*). Grasping a bug in a pair of small forceps, I offered it to a wasp. She darted at the bug and, with her mandibles, dashed it to the shelf below. I presented it to her four times in succession. Each time she behaved as above. The fifth time the squash bug was presented, the wasp darted at the forceps and struck out with her sting, which slipped along the forceps and stuck in my finger. The wasp fell to the shelf below and then returned to the nest. A few minutes later I offered her a cabbage butterfly caterpillar, to which she responded in the usual manner. Although regularly supplied with caterpillars, yet these wasps would occasionally feed their young upon honey collected from a watch glass.

At five minutes to five on the afternoon of August the twenty-eighth a wasp found the crack above the door and passed through

to the outside. A few moments later I found her hovering before the insectary, with her face towards the building, repeatedly ascending and descending and moving now to the right and now to the left in irregular curves; she seemed to be inspecting the front wall of the shed. Shortly the wasp flew into my neighbor's yard and I reëntered the insectary to await developments. Twenty minutes later she returned with a ball of malaxated food in her jaws and proceeded to feed the wasps on the nest and to enter, one by one, the uncapped cells. Once these cells contained living wasp larvæ; but now they were either empty or occupied by the dried remains of the dead. A few days ago the last large larva had woven its cocoon and the last of the small ones had died. For several days this wasp continued to hunt and on her return always entered the uncapped cell. Had the "widow-mother" lived, each cell would have contained a larva or an egg, and the worker wasps would have fed them. Following an instinctive tendency to feed the hungry babes that normally would occupy those cells, this wasp repeatedly entered those tenantless cells with food. It was a pathetic sight to watch the creature repeatedly and industriously attempting to perform an impossible instinctive function.

On the night of September the first a wasp emerged from one of the recently capped cells. Another emerged the following night, and in a few days wasps had emerged from all of the newly capped cells. While in the larval stage these wasps fasted from the seventh to the fifteenth of August. From the fifteenth to the nineteenth the only food they received was honey. From the nineteenth until the cells were capped they received the normal food of such larvæ. Yet these insects emerged in perfect form. This result was a surprise to me. Margaret Morley [1] fed four larvæ of a species of Polistes (she does not state which species) on maple sugar and raw egg. One of them died before weaving its cocoon; three wove cocoons that were thin and transparent, but none emerged from the cocoons. Of the three that constructed cocoons, one fell out and died and two died in the cells without developing their wings. Since she fed her wasps for three weeks they were probably much younger than mine when they lost their natural nurses.

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[1] *Op. cit.*, pp. 177–181.

No conclusive evidence of paper making by these orphan wasps was obtained. When the nest was obtained there were several unfinished cells. These cells were never finished. On one occasion I thought I detected an addition to the rim of one of the cells containing the large larvæ; but since I had placed no mark on the cell I could not be certain. A day later the silken cap was placed on the cell. The upper extension of the wall of this cell seemed to be of paper; it was not so white as the top of the cap which was woven by the larvæ. To be sure that this portion was constructed of paper, I would have been forced to remove a piece of the wall; and I could not do that without disturbing the pupa within.

It is the first of October; for a week it has been cool enough for fire; this morning a slight frost is whitening the tops of the insectary. All but three of the wasps have disappeared, and those are resting, in a stupor, upon the top of the nest, awaiting an inevitable death.

Summary.

1. These workers of *Polistes pallipes* Lepel. which had never seen the widow-mother of the colony nor associated with any other wasps, performed all the activities of such wasps, except egg-laying and, possibly, paper-making.

2. The large larvæ that had nearly completed their larval period of life, after fasting for eight days, feeding on honey only for the next three days and receiving their normal diet for the remainder of their larval life, constructed perfect cocoons and emerged as normal imagoes. The small larvæ, when submitted to such hardships, died.

3. After being restricted to a honey diet for several days, these wasps became cannibals. Bit by bit, they removed the cap from a pupal cell, decapitated the inmate and ate the contents of its thorax.

4. From the first, these wasps were so tame that they would accept honey or insect larvæ when offered to them on glass rods, in forceps, or even upon my fingers.

5. Lepidopterous larvæ captured for food are not stung. Grasping the caterpillar with her fore feet, the wasp rotates it on its longitudinal axis and gradually elevates it while she malaxates its posterior end until her jaws are filled with a ball of pulpy matter. The remainder of the insect is then dropped.

NOTE ON THE FOLLOWING ARTICLE

Although the following article is written from a medical standpoint, it deals with a matter of practical importance to economic entomologists, and presents the first experimental data bearing on the hypothesis [1] that poliomyelitis (infantile paralysis) may be carried by *Stomoxys calcitrans*.

Since it appeared, Anderson and Frost[2] of the Public Health and Marine-Hospital Service have reported similarly successful results in transmitting poliomyelitis among monkeys, by repeating these same experiments with Stomoxys. They have further been able to induce the disease in a third monkey by inoculation with an emulsion of the spinal cord taken from a monkey that developed the disease after being bitten by infected flies, thus proving the diagnosis in the case of the fly-bitten monkeys. (Ed.)

SOME EXPERIMENTAL OBSERVATIONS UPON MONKEYS CONCERNING THE TRANSMISSION OF POLIOMYELITIS THROUGH THE AGENCY OF *STOMOXYS CALCITRANS*, A PRELIMINARY NOTE.[3]

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The work we are about to report was done for, and under, the auspices of the State Board of Health of Massachusetts.

We should like to have it distinctly understood, and therefore emphasize the fact right in the beginning, that this announcement is to be considered as a preliminary report, for the work is still

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[1] Brues, C. T. & P. A. E. Sheppard, The Possible Etiological Relation of Certain Biting Insects to the Spread of Infantile Paralysis. Month. Bull. State Board of Health of Massachusetts, Dec. 1911, pp. 338–340 and Journ. Econ. Entom., Vol 5, pp. 306–324 (Aug. 1912).

[2] Anderson, J. H. and Frost.

[3] Reprinted from the Monthly Bulletin of the State Board of Health of Massachusetts, Vol. 7, n. s., pp. 314–317. (September, 1912).